DIGITAL SAFETY ANALYZER
Model 170

OPERATOR'S MANUAL

&

Service

BIO-TEK
INSTRUMENTS, INC.

Service

BIO-TEK[R] INSTRUMENTS, INC.

ELECTRICAL SAFETY ANALYZER

MODEL 170

OPERATOR'S MANUAL

MANUAL PART NUMBER 94037

FOR SERIAL NUMBERS 0001 AND UP

REVISION H

APRIL 1990

BIO-TEK INSTRUMENTS, INC.

HIGHLAND PARK, BOX 998

WINOOSKI, VT 05404-0998 USA

802-655-4040

800-451-5172

800-24-BIOTK (SERVICE)

TELEX 94-0136 BIO TEK SHVT

FAX 802-655-7941

DOCUMENT REVISION RECORD

Revision	Date	Section	Changes
A through D			Revisions prior to addition of Document Revision Record.
E	10/31/86	Title Page	Updated Title Page.
		Document Revision Record	Added page for Document Revision Record.
		Section 2.2	Updated illustration.
		Section 3.0	Under Input Impedance, added "when unit is turned ON."
		Schematics, Component Layouts Assembly Drawings, & Parts Lists	Updated all engineering drawings and parts lists.
F	5/15/1988	Title Page	Added FAX number.
		Sections 6.3 & 6.4	Reversed order of sections so that Ground Wire Resistance Measurement comes before Chassis Leakage Measurement.
			Added NOTE at beginning of Section 6.4.

R Bio-Tek is a registered trademark of Bio-Tek Instruments, Inc.

10.0 MEASURING LEAKAGE CURRENT THROUGH THE GROUND WIRE

10.1 Introduction..... 22
10.2 Setup and Measurement..... 22

11.0 TESTING ISOLATED POWER SYSTEMS/GFI'S

11.1 General..... 23
11.2 Setup..... 23
11.3 Operation..... 23
11.4 Testing Ground Fault Interrupters..... 24
11.5 Setup..... 24
11.6 Operation..... 24

12.0 PRINCIPLES OF OPERATION

12.1 Introduction..... 25
12.2 Micro amp/Millivolt (Leakage Current) Section..... 25
12.3 Digital Voltmeter..... 25
12.4 OHMS (Ground Wire Resistance) System..... 25
12.5 Input Switching..... 26
12.6 Power Supply..... 26
12.7 AC Test Receptacle..... 26

13.0 CALIBRATION PROCEDURES

13.0 Calibration Procedures..... 27

Schematics:

Circuit..... S1
Wiring..... S2

Component Layout:

Display PCB..... C1
Function Switch PCB..... C2
Power Supply PCB..... C3

Parts List:

Display PCB..... PL-1
Power Supply PCB..... PL-4
Switch PCB..... PL-5
Front Panel..... PL-6
Back Panel..... PL-8
Case..... PL-10
Lead..... PL-11
Accessories..... PL-12
Final Assembly..... PL-13

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 General..... 1
1.2 Applications..... 1
1.3 Testing Capabilities..... 2
1.4 Establishing Safety Standards..... 3
1.5 Record Keeping and Tagging..... 4

2.0 DESCRIPTION

2.1 Front Panel..... 5
2.2 Back Panel..... 6
2.3 Optional Equipment..... 7
2.4 Accessories..... 7
2.5 Optional Accessories..... 7

3.0 SPECIFICATIONS

3.0 Specifications..... 8

4.0 SETUP AND SYSTEMS CHECK

4.1 Setup..... 10
4.2 Self Check..... 10

5.0 RECEPTACLE TESTING

5.1 Introduction..... 12
5.2 Polarity Testing..... 12
5.3 Neutral To Ground Resistance Testing..... 12
5.4 Resistance and Potential Difference Between Two Receptacles..... 14
5.5 Line Voltage..... 14

6.0 PORTABLE DEVICE TESTING

6.1 Introduction..... 15
6.2 Setup..... 15
6.3 Ground Wire Resistance Measurement..... 16
6.4 Chassis Leakage Measurement 16
6.5 ECG Lead Leakage Measurement..... 17

7.0 TESTING PORTABLE DEVICES IN ISOLATED POWER AREAS

7.1 Introduction 18
7.2 Testing IPS Devices On A Grounded Power System..... 18
7.3 Testing IPS Devices In The IPS Area..... 18

8.0 TESTING PERMANENTLY WIRED DEVICES

8.1 Introduction..... 19
8.2 Setup and Measurement..... 19

9.0 DUAL LEAD MEASUREMENTS

9.1 Introduction..... 21
9.2 Setup And Measurements..... 21

DOCUMENT REVISION RECORD

Revision	Date	Section	Changes
G	3/21/1989	Title Page	Added registered trademark symbol and new Service Department telephone number.
		Document Revision Record	Added registered trademark statement.
H	4/1/1990	Section 13.0	Item #4, Step C changed to read: "Next connect the red lead of the DVM to TP4..."
			Item #5, Step A changed to read: "... adjust R21."
			Item #5, Step B changed to read: "With the red lead of the DVM connected to TP4..."
			Item #8, Step B changed to read: "Adjust R29 until 170 reads 19.99."
		Schematic	Updated schematic to Revision F.

Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_10689

1.0 INTRODUCTION

1.1 General

The Model 170 Electrical Safety Analyzer is a portable, solid state instrument designed to perform all routine tests to determine if electrical devices, conductive surfaces, and receptacles are electrically safe for use according to recognized national safety standards.

The Model 170 has an internal resistance that simulates the lowest impedance which the human body offers to electrical current flow. By simulating the human body, the Model 170 test results indicate the worst case leakage current levels that would pass through the body if it were to offer a path for leakage currents. The Model 170 Electrical Safety Analyzer is a precision device designed to make electrical safety testing uncomplicated and rapid. Simple rotary switch operation, with single range display, makes data collection simple and accurate. Other features which increase user efficiency include: compact size, self-check circuitry, modular design for discrete servicing and a side pouch accessory storage.

1.2 Applications

The Model 170 provides precise data on various parameters that will determine if a device is electrically safe for use.

As a quality assurance test instrument, the Model 170 provides a means to test devices before they are placed in service. A wide range of testing capabilities help indicate if the device will be safe during normal operating conditions as well as under worst case conditions. In addition, certain electrical specifications can be tested according to the manufacturers specifications.

The Model 170. if incorporated into a routine safety program, will provide both immediate and long-term benefits. Electrical degradation of a device will become readily evident from records of test results obtained during each electrical safety survey; thus, instruments can be removed from service before they become an electrical hazard.

In addition, this data will be useful whenever additional purchases of equipment are being considered. By reviewing the amount of repair time required for a given instrument, along with its safety record, it can be decided if repurchasing is cost effective.

1.3 Testing Capabilities

The Model 170 is designed to perform tests recommended by the majority of nationally recognized agencies involved in issuing safety standards. (AAMI frequency response and load)

Receptacles

- .Measure Line Voltage
- .Determine the polarity of each receptacle;
- .Determine if each receptacle is grounded;
- .Determine if the metal face plate of the outlet is grounded;
- .Measure the potential differences and resistances between the grounding pole of one receptacle and the grounding pole of any other receptacle;
- .Measure the potential differences and resistances between the grounding pole of a receptacle on one branch circuit and the grounding poles of receptacles on a different branch circuit fed by the same distribution panel;
- .Measure the potential differences and resistances between the grounding pole of each receptacle and the grounding point that services them;
- .Test neutral to ground resistance of a receptacle.

Portable Devices

- .Measure the potential differences between a device's exposed conductive surfaces and the grounding point that services it;
- .Measure the resistance between a device's exposed conductive surfaces and chassis, and the grounding pin of the plug;
- .Measure leakage currents from a device when it is:

    grounded with normal polarity
    grounded with reversed polarity
    ungrounded with normal polarity
    ungrounded with reversed polarity

* all the above configurations may also be performed with the open-neutral test.

Equipment With Leads

- .Measure leakage currents from isolated patient leads;
- .Measure the leakage currents from non-isolated patient leads;

.Measure the leakage currents between leads;
.Measure potential differences between leads;
.Measure resistances between leads and exposed conductive surfaces;

Fixed Equipment

.Measure the potential difference between exposed conductive surfaces of fixed equipment serviced by the same distribution panel;
.Measure the resistance between exposed conductive surfaces of fixed equipment and the grounding pole of a power receptacle serviced by the same distribution panel;
.Measure the potential differences between exposed conductive surfaces of fixed equipment serviced by different distribution panels;
.Measure the resistance between exposed conductive surfaces of fixed equipment serviced by different distribution panels;
.Test for continuity of ground between each grounding point and the exposed conductive surfaces of fixed equipment it services;
.Measure leakage currents from fixed equipment.

Conductive Surfaces

.Measure the potential differences between the grounding pole of one of the receptacles and each exposed conductive surface;
.Measure the resistance of the grounding cord servicing each exposed conductive surface;
.Measure the potential difference between each conductive surface located in a given area;
.Measure the resistance between each grounding point and the exposed conductive surface it services;
.Measure the leakage currents from exposed conductive surfaces.

1.4 Establishing Safety Standards

Due to variation in acceptable standards presently being suggested and enforced by the various agencies, organizations, and institutions, this manual does not include suggested acceptable levels for each test procedure.

Each test should be performed in accordance with the test procedures presented in this manual, but refer to your safety programs specifications to determine if the results obtained are acceptable, or if the item tested should be repaired or replaced.

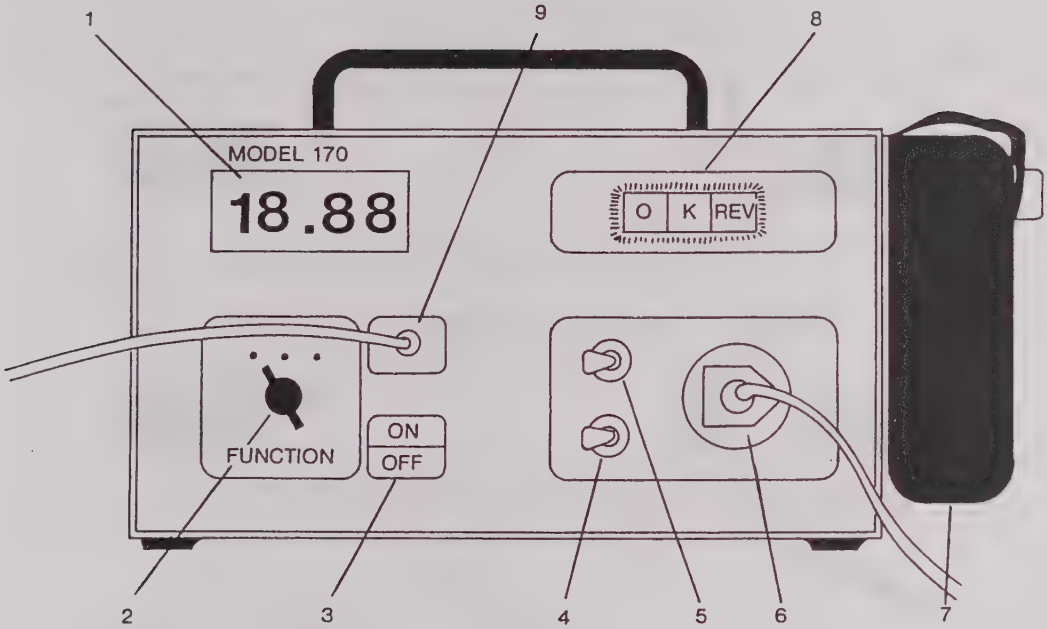
If you have questions concerning standards, write to the appropriate agency, or write to Bio-Tek Instruments for information, specifying the application and area of concern. Bio-Tek Instruments has a manual on safety testing and standards, available at a nominal cost.

1.5 Record Keeping And Tagging

Bio-Tek Instruments has a complete Record Keeping and Tagging System available that will fit into any program. Write or call the Sales Department, Bio-Tek Instruments, Inc., Highland Park, Box 998, Winooski, VT 05404-0998, 800-451-5172 for information.

2.0 DESCRIPTION

2.1 Front Panel



1. Digital Display: Large .5" LCD digits indicate magnitude of the measurement.

2. Function Selector: Selects Line Voltage, Chassis Leakage, or Ground Wire Resistance.

3. On/Off: Powers the 170.

4. Ground Switch: Breaks the ground wire of the device to allow complete testing.

5. Polarity Switch: This switch reverses the polarity of the test receptacle for complete product testing.

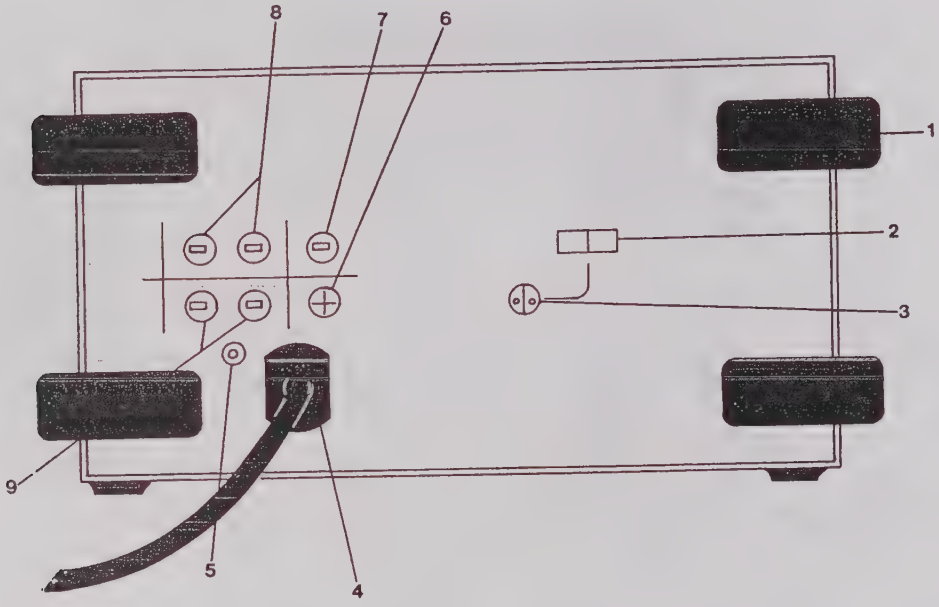
6. Test Receptacle: The hospital grade test receptacle brings the test point to the front panel for easy testing.

7. Accessory Pouch: Holds all spare fuses and accessories.

8. Receptacle Check Lights: Indicates wall receptacle condition when 170 is plugged in.

9. Test Lead: The signal to be measured is applied between the test lead and ground.

2.2 Back Panel



1. Cord Wrap: Provides storage for the line cord and acts as feet for using 170 on its back. In all four corners.

2. Lead Select: Allows the user to select either single or dual lead for taking measurements.

3. Black Lead Input: Connect black lead to this input for dual lead measurements.

4. Line Cord: Heavy duty line cord.

5. Ground Pin: Attached to the front panel's receptacle ground.

6. Chassis Ground Connector: Knurled nut provides easy connection to chassis of model 170.

7. Fuse Holder: .10 Amp fuse for ohm's 10ma current source.

8. Fuse Holder: 1/4 Amp fuses for Model 170 power supply.

9. Fuse Holder: 15 Amp fuses for front panel receptacle.

2.3 Optional Equipment

Most hospital operating rooms are equipped with explosion proof receptacles. Bio-Tek offers adaptor cords to allow the Model 170 to effectively test these areas.

Model	Manufacturer
NF23/1, NF23/2	Hubbell

The "/1" units are equipped with a male explosion proof connector and a female three prong plug.

The "/2" units are equipped with female explosion proof type connector and a male three prong plug.

2.4 Accessories

The following accessories are provided with the Model 170. Part numbers are listed for use in ordering any extra accessories desired.

Large Clamp - 7770014
1/4 Amp Fuse (2) - 46001
15 Amp Fuse (2) - 46007
1/10 Amp Fuse - 46019
Ground Adaptor - 48005
Test Probe - 48031
Lead Set - 1700017

2.5 Optional Accessories

Model CC3 Carrying Case

The Model CC3 is a custom carrying case designed to conveniently and safely transport your Model 170 and all its accessories. The exterior is constructed of durable thermoplastic with a shock absorbant polyfoam interior.

This tough aluminum reinforced case comes with a full five year guarantee against all defects in materials and craftmanship. Order using our part number 93090.

Features

.Heavy duty ABS exterior
.Shock absorbant polyfoam interior
.Rugged steel core handle and draw bit lock
.All edges and corners reinforced with aluminum

3.0 SPECIFICATIONS

Micro Amp/Millivolts:	0-1999 uA, ± 1% of reading ± 2 uA.
Resistance:	0-19.99 ohms ± 1% of reading ± .03 ohms.
Input Impedance:	1000 ohms ± 1% when unit is turned ON.
Frequency Response:	DC - 1000 Hz per AAMI, Amplifier frequency response DC - 100 K Hz, True R.M.S.
Display:	LCD, .50" high readout. "1" to the far left of the display indicates overrange.
Conversion Update:	3 times a second.
Outlet Check:	Verifies power, ground, and polarity of wall receptacle while unit is on.
Line Voltage:	Verifies Line Voltage between 100 and 250 VAC. Display reads Line Voltage ± 1% of full scale.
Current Carry	15 Amps at 120 Volts; 10 Amps at 220 Volts, six foot heavy duty line cord; hospital grade plug and receptacle.
Accessories	Large probe and clamp, two 5' leads, two technical manuals, short form instructions.
Dimensions:	8.5 x 4.5 x 4.5" (21.5 x 11.4 x 11.4 cm).
Weight:	4 lbs (1.725 kg).
Environment:	Operating temperature, 0° to 40° C storage temp. -25° to 50° C, humidity to 90% R.H.

Calibration:	Traceable to the National Bureau of Standards (NBS). Recommended recalibration once a year. Send unit to:

Service Department, Bio-Tek Instruments, Inc., Highland Park, Box 998, Winooski, VT 05404-0998. Call 800-451-5172.

4.0 SETUP AND SELF CHECK

4.1 Setup

1. Line Voltage - Your Model 170 can operate on Line Voltages between 100 VAC and 250 VAC. No adjustment is necessary if your Line Voltage falls within the specified range.

2. Input Lead Selector - Select either "single" or "dual" lead mode on the back panel of the Model 170:

   A. The dual lead mode can be used for the following (see section 9.0 for further details):

      a. Measure leakage currents, potentials in millivolts, and resistance between any two points;
      b. Check ground points in a room for point to point resistance and potentials;
      c. Measure leakage currents and ground wire resistance from devices in IPS areas without the use of adaptor cords;
      d. Make miscellaneous measurements independent of ground.

   B. The single lead mode allows testing with one lead which is referenced to ground. This allows the user rapid chassis leakage and ground wire resistance measurements. Most measurements will be made using the single lead measurement

4.2 Self Check

This is a general procedure which insures proper operation of the Model 170 and the A.C. power System. It should be performed each day before testing and before connecting to a new receptacle for testing.

1. Plug Model 170 power cord into wall receptacle.

2. Switch function to "Line Voltage".

3. Turn on Model 170 power switch.

4. The Model 170 digital display should read Line Voltage (VAC) ± 1% of full scale.

5. If the display does not read proper Line Voltage under normal operating conditions, return the Model 170 prepaid and insured for $650.00 to:

   Service Department, Bio-Tek Instruments, Inc., Highland Park, Box 998, Winooski, VT 05404-0998.

6. Self Check in "Line Voltage" insures the following:

   a. Model 170 calibration.
   b. Proper operation of LCD segments;
   c. Tests the receptacle to which the Model 170 is connected for Line Voltage, polarity, and ground, using the three neon lights ("O", "K", "Rev").

Note: The receptacle test is invalid when testing in an isolated power system (IPS) area. An explanation is given in the next section.

5.0 RECEPTACLE TESTING

5.1 Introduction

The model 170 can be used for comprehensive testing of ground referenced power system receptacles. Receptacles can be tested for

A. Polarity
B. Neutral to ground resistance
C. Receptacle to receptacle testing of ground resistance or potential difference.
D. Line Voltage.

Note: Polarity and neutral to ground resistance testing are not valid for an isolated power system (IPS). This is because in an IPS there is no "hot" or "neutral" terminal and no earth ground, as in conventional ground referenced power systems.

5.2 Polarity Testing

1. Plug Model 170 into a wall receptacle.

2. The neon lights should read "O", "K". If not, refer to the following chart for possible receptacle faults:

"O"	"K"	"Rev"	Analysis
●	●	O	Normal Polarity and Ground
●	O	●	Reversed Polarity
●	O	O	No Ground
O	●	O	No Neutral
O	O	●	No Neutral, Reversed Polarity
O	O	O	No Power

5.3 Neutral To Ground Resistance Testing (Dual Lead Mode)

1. Plug Model 170 into a receptacle to be tested.

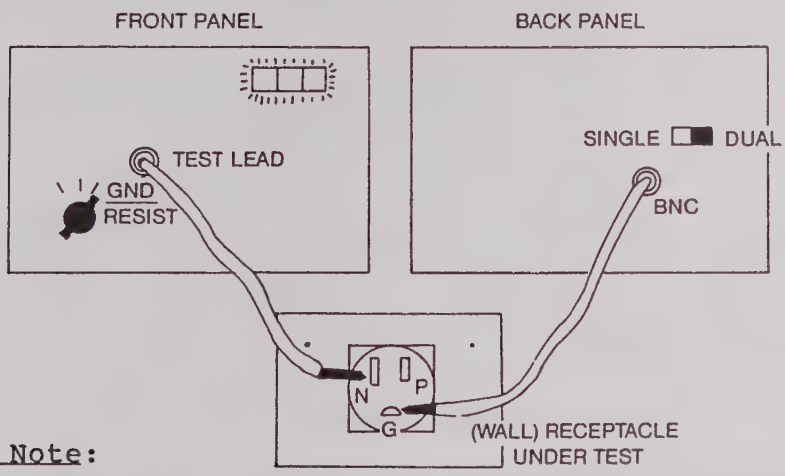
2. Switch to "Ground Wire Resistance" position.

3. Connect the red tipped gray BNC Cable to the front "test lead" jack; the black tipped gray BNC Cable to the rear panel jack at the 170.

4. Connect appropriate probes to the red and black banana plugs of the two gray cables.

5. Connect the probe with the black tip to the ground point and the probe with the red tip to the neutral, of the receptacle to be tested.

6. Record the resistance between the two points in ohms.



Application Note:

OBSERVATION: Sometimes during the neutral to ground resistance testing the Bio-Tek Electrical Safety Analyzer(s) may give erratic readings.

During this test procedure the safety analyzer applies a fixed current (-10 mA DC; -25 mA DC; 10- mA DC for 170. 270 and 501 Models respectively) between the neutral and ground wires. Thje resulting voltage drop due to the unknown resistance between the two wores is measured with an amplifieer. a measure of this voltage drop is displayed by the analyzer as the resistance between the neutral and ground wires.

EXPLANATION: The amplifier circuit mentioned above also has a low pass filter that rejects 50 or 60Hz, 100 mv line interference. However, it is not unusual for much larger amplitude (several volts) signals, of 50/60 Hz or other frequencies, to be floating in the hospital wiring system. These interferences may be due to improper wiring, shielding, distribution system. or grounding. Groud loops and/or appliances and equipment (CAT Scanners, X-Ray equipment, etc.) used in the establishment may also contribute towards extraneous signal levels.

The low pass filters in the safety analyzers are not designed to eliminate the large signal interference described above. Thus the apparent voltage drop perceived by the safety analyzers' amplifier circuits will not be accurate, resulting in the erratic readings.

SOLUTION:
1. Perform the test with all other appliances and devices connected to the same distribution system unplugged.
2. If the erratic readings persist, you can make a choice between (a) ignoring and eliminating this test or (b) taking steps to have a better wiring, distribution and grounding system.

REMEMBER: THE NEUTRAL TO GROUND RESISTANCE TEST IS NOT REQUIRED BY ANY NATIONAL OR INTERNATIONAL STANDARDS.

5.4 Resistance And Potential Difference Between Two Receptacles (Dual Lead Mode)

1. Follow the first four steps of Section 5.3.
2. Connect one probe to the ground pin of one of the two wall receptacles, the other probe to the ground pin of the other receptacale.
3. Record the resistance between the two points in ohms.
4. By switching the function to chassis leakage, the potential difference between the two points can be recorded in millivolts.

5.5 Line Voltage

Select "Line Voltage" the 170 will indicate line voltage of the receptacle that it is plugged into ± 2.5 VAC.

6.0 PORTABLE DEVICE TESTING

6.1 Introduction

This section describes how to test devices which have an accessible three prong 15 Amp plug. Refer to section 8.0 to test permanently wired devices.

CAUTION: When testing defibrillators for leakage current, do not discharge defibrillators, because you may damage the Model 170.

6.2 Setup

1. Switch "Input Leads" on back panel to single lead mode.

2. Plug Model 170 power cord into wall receptacle.

Note: If devices to be tested are located in an Isolated Power Systems Area (IPS), refer to Section 7.0 for setup procedure.

3. Verify that receptacle check neons read "O", "K". If not, refer to Section 5.2 for fault analysis and correction before proceeding further.

Note: This test is invalid to test devices in IPS Areas, as explained in Section 5.1.

4. Switch function switch to "Line Voltage". The display should read Line Voltage ± 1% of full scale. If not, return the Model 170. prepaid and insured for full value to the Service Department, Bio-Tek Instruments, Inc., Highland Park, Box 998, Winooski, VT 05404-0998.

5. Switch ground and polarity switches to "normal".

6. Attach a clamp to the red banana plug of the gray test lead cable.

7. Plug the power cord of the device under test into the Model 170 power receptacle.

8. Attach the test lead clamp to a screw or bare metal on the chassis of the device under test.

6.3 Ground Wire Resistance Measurement

1. Switch polarity switch to Off position.

2. Switch function switch to ground wire resistance position.

3. The display indicates the resistance in ohms between the device power cable ground pin and the chassis. Bend and manipulate the power cord of the device at the plug and grommet to see if there is any intermittent reading. If the meter reads overrange, the ground wire may be broken or the device may be double insulated. Check the manufacturer's literature to determine if the device is double insulated, in which case this measurement cannot be taken.

If the device is not double insulated and the Model 170 displays overrange "1", the device is defective. Record the reading and tag accordingly.

6.4 Chassis Leakage Measurement

NOTE: When performing an electrical safety inspection of an electromechanical device, the Ground Wire Resistance (refer to Section 6.3) must always be performed first.

1. Switch function switch to chassis leakage position.

2. The display indicates chassis leakage in either micro amps or millivolts. Record readings for each of the following power configurations, with the device under test in both power On and power Off positions:

   Normal Polarity - Normal Ground
   Reverse Polarity - Normal Ground
   Reverse Polarity - Open Ground *
   Normal Polarity - Open Ground *

* If display shows overrange indication "1", switch polarity switch to Off position; unplug and properly tag the device under test; Remove the device under test from normal use until the fault has been corrected.

6.5 ECG Lead Leakage Measurement

1. Follow the first six steps of Section 6.2 setup Procedure.

2. Switch function switch to chassis leakage position.

3. Plug the device under test into the Model 170 power receptacle.

4. Connect the test lead clamp to the ECG lead under test.

5. Display indicates leakage current from the ECG lead to ground. Rotate the ECG selector switch to each position. Record the readings, for both power On and power Off positions of the device under test, for each of the following:

   Normal Polarity - Normal Ground
   Reverse Polarity - Normal Ground
   Reverse Polarity - Open Ground
   Normal Polarity - Open Ground

Note: If display indicates overrange "1", switch polarity switch to Off position, disconnect the device and tag accordingly.

Note: The ECG machine selector switch may be on any lead for all ECG lead leakage tests.

7.0 TESTING PORTABLE DEVICES IN ISOLATED POWER AREAS

7.1 Introduction

It is recommended that devices used in areas with isolated power systems be tested in areas with a grounded (conventional) power system. The isolated power system (IPS) can decrease leakage current values substantially. In addition, leakage current standards are defined for grounded power system operation.

However, testing can be done either outside or inside the IPS areas. Section 7.2 describes testing the devices using a grounded power system and Section 7.3 describes testing in the IPS area.

The optional adaptor described in Section 2.3 are used to adapt the IPS special power connectors for use with the Model 170.

7.2 Testing IPS Devices On A Grounded Power System

1. Remove the device under test to an area with ground referenced power.E
2. Plug the device into an adaptor cord (Models NF23/1 NF23/2) with a female explosion-proof receptacle on one end of the adapter cord. Connect the other end of the adapter cord to the receptacle on the front panel of the Model 170.
3. Plug the Model 170 line cord into a wall receptacle.
4. The device can now be tested in accordance with Sec. 6.

7.3 Testing IPS Devices In The IPS Area

1. Connect the female explosion-proof receptacle of an adaptor cord (Models NF23/1, NF23/2) to the male plug of the device under test.
2. Plug the other end of the adaptor cord into the Model 170 test receptacle.
3. Plug a male explosion-proof plug from an adaptor cord (Models NF23/1, NF23/R) into a receptacle in the IPS area.
4. Plug the line cord of the Model 170 into the female receptacle of the adaptor cord of step 3.
5. Proceed as instructed in Section 6.

8.0 TESTING PERMANENTLY WIRED DEVICES

8.1 Introduction

Permanently wired devices can be tested only with the device On or Off. This is in contrast for portable units which can plug into the Model 170 power receptacle and have the receptacle conditions varied by the 170 front panel switches. Proceed to 8.2 if a power outlet or adaptor cord is available for the Model 170 which has the following characteristics:

1. The device under test and the Model 170 should have a common ground;

2. The ground wire length between the Model 170 and the device under test should be as short as possible. This will avoid spurious readings due to long ground wire connections between the two instruments.

If a power outlet or adaptor cord for the Model 170 is not available or the power outlets for the 170 and the device under test cannot have a short, common ground connection, proceed to Section 9.0

8.2 Setup And Measurements

1. Switch to single lead measurement mode.

2. Attach a clamp to the red banana plug of the gray test lead.

3. Plug Model 170 power cord into a power receptacle.

4. Switch function switch to "line voltage" and verify the following:

   A. Receptacle check neon lights show "O" "K".
   B. Display reads line voltage ± 1% of full scale.

(Receptacle check is invalid in IPS areas-see Section 5.1).

If either one of above or both of above are not satisfactory, refer to Section 5.2 for polarity analysis and Section 4.2 for self check analysis.

5. Attach the test lead clamp to a bare metal or chassis of the device under test.

6. Switch function switch to chassis leakage. Record the readings for the device in the On and Off situations.

7. Switch function switch to ground wire resistance position. Record reading in ohms.

8. For ECG lead leakage measurement, switch function switch to chassis leakage and follow steps 4 and 5 of Section 6.5.

.0 DUAL LEAD MEASUREMENTS (MEASUREMENT BETWEEN CONDUCTIVE SURFACES)

9.1 Introduction

The Model 170 can measure currents, potentials and resistances between any two points, in the dual lead measurement mode. These measurements can be useful to:

1. Check resistance, potentials and leakage currents between two ground points, between neutral and ground pins, and generally any two conductive points.
2. Check leakage currents between any two ECG leads.
3. Check ground wire resistances and leakage currents of devices in IPS areas and of permanently wired devices.
4. Make measurements independent of ground.

9.2 Setup And Measurement

1. Switch to dual lead for input lead selection, on the back panel of the Model 170.
2. Connect the gray cable with the red banana plug to the front panel test lead BNC jack and the gray cable with the black banana plug to the back panel BNC jack (ground/reference).
3. Attach probes or clamps to the banana plugs, as appropriate.
4. Plug Model 170 power cord into a wall receptacle.
5. Switch function switch to line voltage and verify the following:

   A. Display reads line voltage ± 1% 1 digit.
   B. Receptacle check neon lights show "O" "K".

   (Receptacle check is invalid in IPS areas-see Section 5.1).

   If either one or both of above are not satisfactory, refer to Section 5.2 and for Section 4.2 for analysis.

6. Connect the two gray cables to the two test points.
7. Switch function switch to the proper mode and take appropriate readings.

10.0 MEASURING LEAKAGE CURRENT THROUGH THE GROUND WIRE

10.1 Introduction

The Model 170 can measure leakage current through the ground wire, providing a quick way to spot check devices. The readings thus obtained are identical to those obtained in Section 6.3 (chassis leakage measurement) and can only be taken on portable devices that can be connected to the Model 170 power outlet. This test is not recommended as a routine inspection since chassis leakage current should be measured at exposed metal part of the device under test.

10.2 Setup And Measurement

1. Select single lead measurement mode.
2. Plug Model 170 power cord into wall receptacle.
3. Connect the red bannana plug of the gray test lead to the green ground pin bannana plug socket on the back panel.
4. Plug the device under test into the Model 170 power outlet.
5. Switch ground switch to open position, function switch to chassis leakage mode.
6. Record readings for normal and reverse polarity, with the device under test in the power On and Off states.

Caution: If display shows overrange "1", switch polarity to Off, disconnect and properly tag the device under test.

11.0 TESTING ISOLATED POWER SYSTEMS/GFI's

11.1 General

The Model 170 when used with a Bio-Tek Universal Isotester can thoroughly test LIM's for the following:

Macro Fault: Measures the total leakage in the IPS unit on line A or B. Macro Fault reads directly on the Model 170.

Trip Point: Tests the LIM's audible and/or visual alarm by simulating a variable fault to ground. Leakage to ground is taken from side A and B independently. Trip point reads directly on the calibrated Universal Isotester.

Trip Point Balanced: Tests the trip point of the LIM under simultaneous fault conditions. The fault current/ resistance is varied simultaneously on both lines A and B allows calibration of LIM trip point. Read directly on the calibrated Universal Isotester indicator.

11.2 Setup

1. Setup 170 for dual lead, with the polarity and ground switches in normal position, function switch on "Chassis Leakage".

2. Plug the Universal Isotester into the front of the Model 170's receptacle and plug 170's leads into Isotesters input jacks.

3. Connect the plug of the Model 170 to the appropriate adaptor for connection to the isolated power system.

11.3 Operation

1. Push the macro fault side A button on the Universal Isotester.

Results: The Model 170 will indicate the total leakage to ground of the isolated power system. This reading should be approximately equal to the LIM meter indicator reading.

Requirements state that a LIM should not introduce greater than 1 milliamp of leakage to the system. Adding a factor for leakage due to wiring and devices connected could bring the macro fault up to 1.5 milliamps (1500 uA)

2. Push the macro fault side B button. The results should be the same as step 1.

3. Rotate the Universal Isotester's trip point knob fully counter clockwise.

4. Push trip point A button. Rotate Universal Isotester's trip point knob back slowly clockwise.

5. Record the knob reading when the alarm sounds.

6. Repeat steps 3, 4 and 5 with side B button pushed.

7. Push LIM trip point A and B. This simultaneously introduces a balanced fault on each line to ground. The reading should be similar to the reading obtained in side A and B tests. This system can be used to calibrate the LIM trip point of the LIM.

Please Note: Isolated power test forms may be ordered from Bio-Tek. Call Sales Department at 800-451-5172 for more information.

11.4 Testing Ground Fault Interrupters

1. Universal Isotester option allows the Model 170 to thoroughly test ground fault interrupters for actual trip points.

11.5 Setup

1. Attach Universal Isotester to the 170 (see Section 11.2).

2. Plug Model 170 into the GFI under test.

11.6 Operation

1. Turn Universal Isotester GFI trip point knob fully counter clockwise.

2. Turn GFI trip point know slowly clockwise until GFI is tripped note knob reading and record.

12.0 PRINCIPLES OF OPERATION

12.1 Introduction

The operation of the Model 170 can be divided into five systems:

Micro Amp/Millivolt Amplifier
Ohms System
Digital Voltmeter
Power Supply
Input Switching and Test Receptacle

Each system of the Model 170 is described in general to define the overall operation of the Model 170. Refer to schematic as an aid to explanation.

12.2 Micro AmP/Millivolt (Leakage Current) Section

The input of the Micro Amp/Millivolt Section, with over 100K ohms of input impedance, is in parallel with the AAMI test load. The signal is then attenuated by a factor of ten and inverted by operational amplifier U3.

The output of the amplifier goes directly into U4 a

precision r.m.s. to D.C. converter. This converter takes any signal, positive or negative, D.C. to 1MHz, and converts it into a D.C. voltage that is equal to the root mean square of the input signal.

This D.C. voltage is then measured by the Digital Voltmeter Section and displayed directly in micro amps/millivolts.

12.3 Digital Voltmeter

The Model 170 Digital Safety Analyzer uses a precision analog to digital converter system which converts the analog voltage to digital signals which drive the display. This is accomplished on a single CMOS intergrated circuit, U1.

12.4 OHMS (Ground Wire Resistance) System

To make resistance measurements, a -10 mA DC current source is applied to the unknown resistance and the resulting voltage drop is measured with an amplifier that rejects 50 or 60 Hz interference. On the schematic 1/2 of U3 and Q1, act as the current source, and U5 is the amplifier and low pass filter. The various diodes are for protection against the inadvertant application of line voltages to the ohms circuit.

The 170 does this using a four point resistance technique. This technique negates any inaccuracies due to lead length's. Thus no manual zeroing of the 170 is needed.

12.5 Input Switching

The input switching provides easy use by making or breaking all connections needed for each function. The rotary switch is non-shorting to prevent damage between functions.

12.6 Power Supply

The power supply for the 170 is derived from the AC line voltage. The line voltage is stepped down by T1 and then full wave rectified to ± DC voltage which is then filtered and regulated via VR1 and VR2 to +5 V and -5 V respectively.

T1 is well protected by 1/4 Amp fuses and allows either 115 V or 230 V operation without any adjustment.

12.7 AC Test Receptacle

The Model 170 allows the operator to alter the AC power supply configuration on the device under test. The test receptacle is connected to the AC line by toggle switches which alter polarity to ground.

The AC line is also connected to the receptacle check circuit which indicated AC line status.

13.0 CALIBRATION PROCEDURES

1. First take the Model 170 out of its case.

2. Plug Model 170 into wall receptacle.

3. Select Dual Lead operation on the back panel and connect both the red and black tipped leads to the 170 via the BNC connectors also connect the banana plugs of the leads together.

4. At this point you will need a DVM that is capable of reading .0000 volts.

   A. Connect the black lead of the DVM to the GND test point. Select chassis leakage on the 170. Set DVM to read DC volts.

   B. Now connect the red lead of the DVM to TP1 and adjust R11 for .0000 Volts on the DVM.

   C. Next connect the red lead of the DVM to TP4 and adjust R16 for .0000 Volts on the DVM.

5. Keep the leads on the 170 shorted together and select GRD wire ohm function

   A. With the DVM red lead connected to TP2 measure .0000 Volts, if not adjust R21.

   B. With the red lead of the DVM connected to TP4 adjust R24 for a reading of .0000 Volts DC.

6. Select "Chassis Leakage" on 170.

   A. Apply 1.900 Volts DC to the input leads of the 170.

   B. Adjust R9 until the 170 display reads 1900.

   C. Reverse polarity of the input power to see if 170 still reads 1900 or .5% (1904-1896).

   D. Go through the rest of the DC micro amps readings and record them on the calibration sheet. Also go through AC micro amp readings. 10 uA, 100 uA, 1000 uA, 1900 uA DC, AC ± 1%.

7. Select "Line Voltage"

    A. Adjust R27 so 170 display reads correct line voltage ± 2.5 VAC.

8. Select "Ground Wire Ohm"

    A. Connect the 170 leads to a precision 20.00 ohm resistor.

    B. Adjust R29 until 170 reads 19.99.

    C. Take the rest of the 170 ohms readings and record them. .5 ohm, 1.0 ohm, 5 ohm, 10 ohm, 19,99 ohm ± 1%.

9. Calibration Complete:

    A. Check to make sure receptacle check lights read OK.

    B. Unplug 170 and put it back in its case.

    C. 170 is ready for use.

UNUSED SEGMENTS OF DISPLAY TIED TO BP

DSP1 18.88

R2 100K

U2 (14, 2)

35,9, 7,11, 13

+5V

7106 A/D U1

31 +

30 38 39 40 33 34 1 26 29 28 27

32,35

36

C1 .01uf

100PF C2 100K R3

.1uf C3

+5V-5V

47K R4 .22uf C5

R1 1M 1%

R6 442Ω 1% R5 21K 1% +5V

+5V R16 500K 10T NULL -5V

R15 470K

R14 100Ω

AD636 U4

TRUE RMS TO DC CONVERTER

C10 22uf

R13, 10K

C7 22uf -6V

C8 22uf

2.2 100Ω R12 +5V

1uf C9

.1uf C12

SYMBOLS

- ▼ CIRCUIT GRD
- ▽ SINGLE SECTION FOR CIRCUIT GRD (NO GRD LOOPS)
- ○ 22 AWG FROM PCB

FROM FRONT PANEL SWITCH

TABS H N

T1 DST-4-24

1 2 3 4 5 7 8

D9 D10 D11 D12 IN4004's

TO R28

VR1 +5V 78L05 .1uf 22uf C16 C17

470 C20

VR2 -5V 79L05 .1uf 22uf C18 C19

C21 470uf

POWER SUPPLY PCB. BACK PANEL

DISPLAY PCB FRONT PANEL

LINE VOLTAGE GRD WIRE CHASSIS LEAKAGE

10 FUNCTION PCB FRONT PANEL 10

S3

TO FRONT PANEL BNC

BLU 6 TO CHASSIS GND

GRN 5

YEL 4 FROM 1A FUSE

10MA

TO PIN 8 OF T1

54.9K R28 10K 10T R27 ON FUNCTION PCB

TP1

IN4148 D14 -5V

R8 100K 1%

UA GAIN 2K 10T R9

R10 8.87 1%

-5V R11 14.10K 10T NULL

½ U3 2

D13 IN4148

+5V

uA AMPLIFER

TO FRONT PANEL BNC BLK

TP4

TP3

TP2 OHMS AMPLIFIER

C13 .1uf

140K R17 (2) IN751 5.1V D7, D8

R18 140K 1%

R19 140K 1%

½ TL083 U5

25 NULL R21 100K 10T

R22 68K

C14 .1uf

R23 68K

.68 C15

+5V-5V

½ TL083 U5

NULL R24 100K 10T

+5V

R25 100Ω

R26 100Ω WH

TO ½A FUSE BACK PANEL

140K R20

(2) IN751 5.1V 05.06 D5, D6

OHMS IV ADJUST

R29 10K 10T

R30 2K

-5V +5V

¼ U3

Q1 2N4123

D1 1W4004

10MA CURRENT SOURCE

D2 1W4004

D4 47V

D3 1W4004

R31 220Ω -5V

J1 J2 +5V -5V

*S3-6 POLES, 3 POSITIONS

R7 10Ω 1W 1%

C6 .15uf 600V 5%

R34 10Ω 1W

R32 1K 1% 25W AAMI LOAD

SL

BRW1

TO BACK PANEL BNC RED 2

SINGLE LEAD

DUAL LEAD

OR 3

TO GRD PIN FRONT PANEL

REV	DESCRIPTION	DATE
F	Remove U3 Part No. Desig. ECO 5667	5/18/84
E	Add R34 ECO 5493	2/6/84
D	Change C20 & C21 from 100uf to 470uf ECO 2208	6-13-35
C	Change TP5 to TP4 ECO 1609	10-27-84
B	Delete C11 Change C10 to 22uf ECO 1356	10-18-84
A	Release to Production ECO 1244	6 7 84

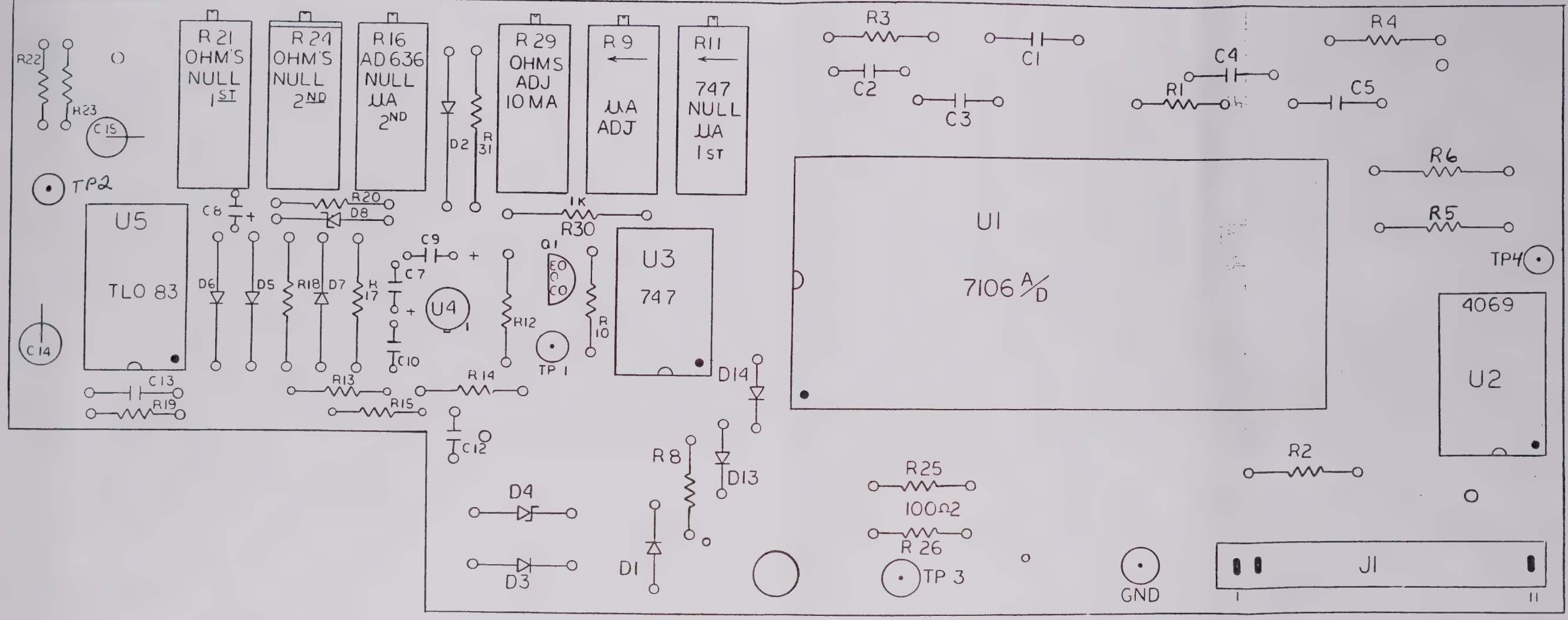
BIO-TEK INSTRUMENTS, INC. HIGHLAND PARK BOX 866 WINOOSKI, VT 05404-0998

APPROVALS	DATE
DRAWN Mike Young	2/22/84
CHECKED	

MODEL 170 Schematic

SCALE NONE SHEET 1 of 2

DRAWING NO. 170.0023-SC



BIO-TEK INSTRUMENTS, INC.
HIGHLAND PARK, BOX
WINOOSKI VT 05404-0966

DISPLAY PCB 170

REV	DESCRIPTION	DATE	APPROVALS	DATE
B	Delete C11 ECO 1693	1-30-85	DRAWN	
A	Release to Production ECO 1244	6-7-84	CHECKED	

SCALE NONE
SHEET
DRAWING NO. 1700014-AS

FRONT PANEL

REAR PANEL

S2

S4

OFF

ON

TO POWER PCB ABS

HOT

NEUT

GRD PIN

CHASSIS GRD

OR. 3

GRN 5

FROM POWER PCB

BR. 1

RED 2

BNC #2

F1 1/4 A

1/4 A

F2

NORM

REV.

OPEN

GND

BLU 6

BLACK

BNC #1

ROM POWER UP PCB

ROM DISPLAY PCB

F3 15A

15 A F4

PLUG

NEUTRAL

HOT

GND

F5

1/10 A

YEL 4

TO POWER PCB

WH

FROM DISPLAY PCB

110K 5% R33

O K REV

POLARITY LIGHT

CHASSIS GRD

GRD LUG

CHASSIS GRD

RECEIVED

FEB 1984

REV	DESCRIPTION	DATE

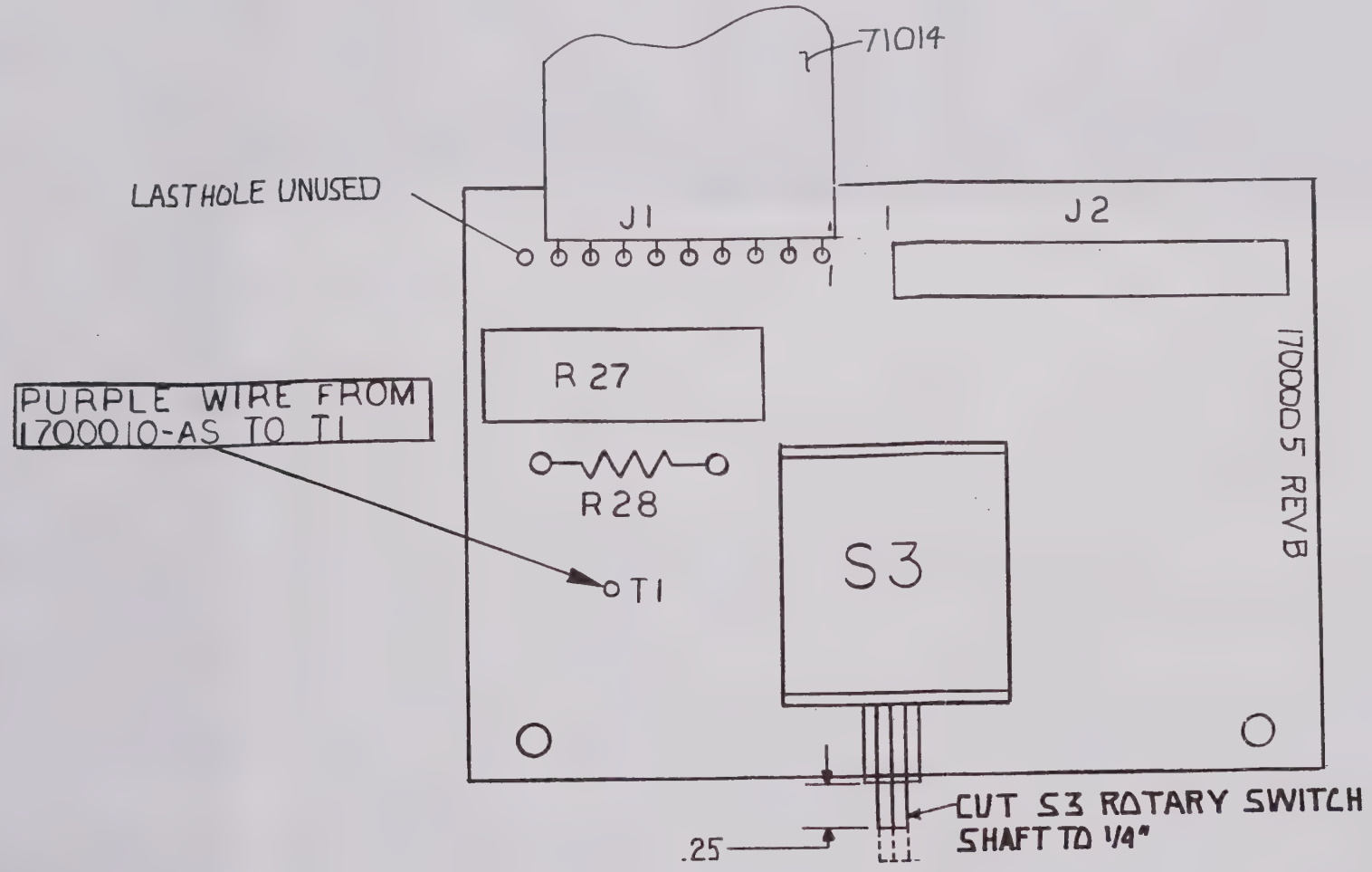
BIO-TEK INSTRUMENTS, INC.

HIGHLAND PARK, BOX
WINOOSKI VT

Rev F

FRONT-REAR PANEL
MODEL 170 Schematic

APPROVALS	DATE	SCALE NONE	DRAWING NO.
DRAWN Mike Young	2/23/84		
CHECKED		SHEET 2 of 2	1700023-SC



BIO-TEK
INSTRUMENTS, INC.
★MILL STREET★★★★★
BURLINGTON, VT 05401
HIGHLAND PARK, BOX 998
WINOOSKI, VT. 05404-0998

REV	DESCRIPTION	DATE
B	REV PER ECO 3198	5-16-86
A	Release to Production ECO 1244	6-7-84

APPROVALS	DATE
DRAWN Mike Young	2/23/84
CHECKED	

FUNCTION SWITCH
170 PCB

SCALE 2=1

DRAWING NO. 1700015-AS

SHEET

STANPAT PRODUCTS INC PORT WASHINGTON N Y

10/30/86 BILL OF MATERIAL PAGE 1

KITTING LIST

1700014 170 PCB ASBY DISPLAY RUN # QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
*	*** REVISION LEVEL ***	D 06-03-86	99	.00	.00	
04005	DISPLAY LCD 3.5 PINLESS	DSP-1	12	1.00	1.00	
12039	SCR PAN #2x1/4 ST SS SLOT		2	2.00	2.00	
1700004	PCB 170 DISPLAY		8	1.00	1.00	
21003	DIODE 1N4004 1A 200V	D1-3	2	3.00	3.00	
21004	DIODE 1N4148 SIGNAL	D13,14	2	2.00	2.00	
22017	DIODE 1N5231B ZENER 5.1V	D5-8	6	4.00	4.00	
22027	DIODE 1N750A ZENER 4.7V5%	D4	6	1.00	1.00	
23003	IC 636 RMS-TO-DC CONVERTR	U4	8	1.00	1.00	
23036	OP AMP TL083 DUAL	U3,5	8	2.00	2.00	
25012	IC 4069 HEX INVERTER	U2	8	1.00	1.00	
25042	IC 7106 A/D CONV 3.5 DGT	U1	8	1.00	1.00	
26002	TRANSISTOR 2N4123 SIG NPN	Q1	8	1.00	1.00	
31101	RES 100.0 OHM 5% 1/4W	R12,14,25,26	2	4.00	4.00	
31103	RES 10.0K OHM 5% 1/4W	R13	2	1.00	1.00	
31104	RES 100.0K OHM 5% 1/4W	R2,3	2	2.00	2.00	
31202	RES 2.0K OHM 5% 1/4W	R30	2	1.00	1.00	
31221	RES 220.0 OHM 5% 1/4W	R31	2	1.00	1.00	
31473	RES 47.0K OHM 5% 1/4W	R4	2	1.00	1.00	
31474	RES 470.0K OHM 5% 1/4W	R15	2	1.00	1.00	

10/30/86 BILL OF MATERIAL PAGE 2

KITTING LIST

1700014 170 PCB ASBY DISPLAY RUN # QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
31683	RES 68.0K OHM 5% 1/4W	R22,23	2	2.00	2.00	
32030	RES 100.00K OHM 1% 1/4W	R8	2	1.00	1.00	
32033	RES 140.00K OHM 1% 1/4W	R17-20	2	4.00	4.00	
32039	RES 1.00M OHM 1% 1/4W	R1	2	1.00	1.00	
32065	RES 21.00K OHM 1% 1/4W	R5	2	1.00	1.00	
32116	RES 442.00 OHM 1% 1/4W	R6	2	1.00	1.00	
32145	RES 8.87K OHM 1% 1/4W	R10	2	1.00	1.00	
34005	TRIMPOT 10K, 10T	R11,29	6	2.00	2.00	
34007	TRIMPOT 100K, 10T	R21,24	6	2.00	2.00	
34012	TRIMPOT 500K, 10T	R16	6	1.00	1.00	
34013	TRIMPOT 2K, 10T	R9	6	1.00	1.00	
42097	HEDR 11-S RTANG BURNDY		6	1.00	1.00	
42123	CONN LCD DUAL INLINE KIT		6	1.00	1.00	
49014	TERM PCB		2	5.00	5.00	
49056	SOCKET I.C. 40-PIN DIP		6	1.00	1.00	
82004	CAP 22 uF 15V TANT C10		8	1.00	1.00	
82005	CAP 1 uF 35V TANT C9		8	1.00	1.00	
82006	CAP 2.2 uF 35V TANT C7,8		8	2.00	2.00	
83002	CAP 100 pF 1000V DISC C2		8	1.00	1.00	
83007	CAP .01 uF 50V DISC C1		2	1.00	1.00	

10/30/86 BILL OF MATERIAL PAGE 3

KITTING LIST

1700014 170 PCB ASBY DISPLAY RUN # QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
83009	CAP .1 uF 12V DISC	C12	8	1.00	1.00	
84001	CAP .22 uF 250V FOIL	C5	8	1.00	1.00	
84002	CAP .1 uF 100V FILM	C3,13	8	2.00	2.00	
84008	CAP .47 uF 100V FILM	C4	8	1.00	1.00	
84009	CAP 1 uF 100V FILM	C14	8	1.00	1.00	
84010	CAP .68 uF 35V MYLR	C15	8	1.00	1.00	

10/30/86 BILL OF MATERIAL PAGE 1

KITTING LIST

1700013 170 PCB ASBY POWER SUPPLY RUN # QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
*	*** REVISION LEVEL ***	E 01-15-86	99	.00	.00	
1700006	PCB 170 POWER SUPPLY		8	1.00	1.00	
19003	RIVET POP 1/8D .060-.125G		2	2.00	2.00	
21003	DIODE 1N4004 1A 200V	D9-12	2	4.00	4.00	
23026	VOLT REG +5V 78L05A	VR1	8	1.00	1.00	
23029	VOLT REG -5V 79L05	VR2	8	1.00	1.00	
33005	RES 10.00 OHM 1% 1W MF	R7	8	1.00	1.00	
33013	RES 1.00K OHM 1% 25W	R32	8	1.00	1.00	
42063	HEDR .250 MTAB		2	2.00	2.00	
53005	SW SLIDE DPDT GLD	S1	12	1.00	1.00	
61002	TRANSF 115/230 24V-CT	T1	8	1.00	1.00	
71003	CABLE RIBN 10-CON 22 AWG	A/R	2	.00	.00	
71027	WIRE BUS 20 AWG	1"	2	.08	.08	
81009	CAP 1000 uF 25V ELEC	C20,21	8	2.00	2.00	
82004	CAP 22 uF 15V TANT	C17,19	8	2.00	2.00	
83009	CAP .1 uF 12V DISC	C16,18	8	2.00	2.00	
85001	CAP .15 uF 600V 5%	C6	8	1.00	1.00	

10/30/86 BILL OF MATERIAL PAGE 1

KITTING LIST

1700015 170 PCB ASBY SWITCH RUN # QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
*	*** REVISION LEVEL ***	A	99	.00	.00	
1700005	PCB 170 SWITCH		8	1.00	1.00	
32029	RES 54.90K OHM 1% 1/4W	R28	2	1.00	1.00	
34005	TRIMPOT 10K, 10T	R27	6	1.00	1.00	
51018	SW ROT 3-POS 6-POLE	S3	12	1.00	1.00	
71014	JUMPER 3" 10-COND		8	1.00	1.00	

10/30/86 BILL OF MATERIAL PAGE 1

KITTING LIST

1700010 170 FRONT PANEL ASBY RUN # QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
*	*** REVISION LEVEL ***	C 2-20-85	99	.00	.00	
01009	NEON LINE MONITOR		6	1.00	1.00	
12011	SCR PAN 4-40x3/16 SS SLOT		2	2.00	2.00	
14003	NUT HEX 4-40 STEEL		2	4.00	4.00	
15002	LOCKNUT 4-40 STEEL		2	4.00	4.00	
1700001	PANEL 170 FRONT *67010		8	1.00	1.00	
1700007	OVERLAY 170 FRONT PANEL		8	1.00	1.00	
1700014	170 PCB ASBY DISPLAY		1	1.00	1.00	
1700015	170 PCB ASBY SWITCH		1	1.00	1.00	
18004	NUT 4-40 B/W NYLON		2	2.00	2.00	
18007	WSHR FLAT #4 NYLON .115ID		2	4.00	4.00	
31114	RES 110.0K OHM 5% 1/4W	R33	2	1.00	1.00	
42053	TERM FTAB .250 16-14 INS		6	2.00	2.00	
42056	TERM FTAB .250 12-10 INS		6	5.00	5.00	
42086	TERM FTAB .250 22-18 INS		6	4.00	4.00	
42148	RECPT TWIN COAX BNC CHASS		6	1.00	1.00	
45032	KNOB CAP W/LINE 21MM BLUE		6	1.00	1.00	
45038	KNOB BLACK 21mm .125 W/LN		6	1.00	1.00	
49018	BRACKET RIGHT ANGLE		2	2.00	2.00	
49211	SPACER THRU #4x.187 AL HX		2	4.00	4.00	

10/30/86 BILL OF MATERIAL PAGE 2

KITTING LIST

1700010 170 FRONT PANEL ASBY RUN # QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
54003	SW ROCKER 2PST SNAP-IN		12	1.00	1.00	
55001	SW TOGGLE SPST 15A		12	1.00	1.00	
55003	SW TOGGLE DPDT 3-POS 20A		12	1.00	1.00	
71002	WIRE HOOK-UP 14 AWG	BLACK A/R	2	.00	.00	
71002	WIRE HOOK-UP 14 AWG	GREEN A/R	2	.00	.00	
71002	WIRE HOOK-UP 14 AWG	WHITE A/R	2	.00	.00	
71005	WIRE HOOK-UP 22 AWG	BLACK A/R	2	.00	.00	
71005	WIRE HOOK-UP 22 AWG	WHITE A/R	2	.00	.00	
71024	SHRINK TUBE 1/8"	A/R	2	.00	.00	
7770018	RECEPT HOSPITAL *42047		90	1.00	1.00	

10/30/86 BILL OF MATERIAL PAGE 1

KITTING LIST

1700011 170 BACK PANEL ASBY RUN # QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
*	*** REVISION LEVEL ***	D 08-01-86	99	.00	.00	
12022	SCR PAN 6-32x1/4 SS SLOT		2	4.00	4.00	
16009	LKWSHR #6 INT TOOTH STEEL		2	4.00	4.00	
1700002	PANEL 170 REAR		8	1.00	1.00	
1700008	OVERLAY 170 BACK PANEL		8	1.00	1.00	
1700013	170 PCB ASBY POWER SUPPLY		1	1.00	1.00	
42004	BANANA JACK GREEN		6	1.00	1.00	
42008	PLUG HOSP GRA CABLE		6	1.00	1.00	
42025	TERM FORK #8 18-14GA INS		2	1.00	1.00	
42027	TERM RING #8 16-14 GA INS		6	2.00	2.00	
42028	BINDING POST, GND		6	1.00	1.00	
42034	TERM RING #6 22-16 GA INS		2	1.00	1.00	
42056	TERM FTAB .250 12-10 INS		6	1.00	1.00	
42086	TERM FTAB .250 22-18 INS		6	2.00	2.00	
42148	RECPT TWIN COAX BNC CHASS		6	1.00	1.00	
46001	FUSE 1/4A 3AB W/ BOX	F1,2	6	2.00	2.00	
46007	FUSE 15A SLOW BLOW	F3,4	6	2.00	2.00	
46016	FUSEHOLDER UNIVERSAL		6	5.00	5.00	
46017	FUSECARRIER N AMERICAN		6	5.00	5.00	
46019	FUSE 1/10A 250V GLASSTUBE	F5	6	1.00	1.00	

10/30/86 BILL OF MATERIAL PAGE 2

KITTING LIST

1700011 170 BACK PANEL ASBY RUN # QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
49019	STRAINRELIEF FOR SJT 14/3		2	1.00	1.00	
49032	CORDWRAP PLASTIC BLACK		6	2.00	2.00	
71001	POWERCORD 14/3 SJTO		2	6.00	6.00	
71002	WIRE HOOK-UP 14 AWG	A/R	2	.00	.00	
71005	WIRE HOOK-UP 22 AWG	GREEN A/R	2	.00	.00	
71006	WIRE 2-COND 18 AWG TW PR	A/R	2	.00	.00	
71035	SHRINK TUBE 1/4"	A/R	2	.00	.00	
7770106	WASHER,STRAIN RELIEF		90	1.00	1.00	

10/30/86 BILL OF MATERIAL PAGE 1

KITTING LIST

1700012 170 CASE ASSEMBLY RUN # QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
*	*** REVISION LEVEL ***	C 01-11-86	99	.00	.00	
12027	SCR PAN 10-32x5/8 SS SLOT		2	2.00	2.00	
16011	LKWSHR #10 INT TOOTH SZ		2	2.00	2.00	
1700003	CASE 170 TOP		90	1.00	1.00	
1700009	OVERLAY 170 CASE-SHRT INS		8	1.00	1.00	
1700041	CASE 170 BOTTOM		90	1.00	1.00	
19004	SCR PAN #6x1/2 ST #2PHIL		2	4.00	4.00	
19006	RIVET POP AL HEAD/ST SHNK		2	4.00	4.00	
19008	RIVET POP AL HEAD/ST SHNK		2	4.00	4.00	
44040	BEZEL LONG BLACK	PCS,NOT PAIR	90	2.00	2.00	
44041	BEZEL SHORT BLACK	PCS,NOT PAIR	10	2.00	2.00	
44046	EPOXY FOR CASE BEZELS		6	1.00	1.00	
49026	HANDLE		6	1.00	1.00	
49064	FOOT RUBBER 3/16"SQ BLK		2	2.00	2.00	
49153	FASTENER MALE SNAP		2	4.00	4.00	
49222	TILT BAR		6	1.00	1.00	

10/30/86 BILL OF MATERIAL PAGE 1

KITTING LIST

1700017 170 LEAD ASBY RUN # QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
*	*** REVISION LEVEL ***	A	99	.00	.00	
42147	PLUG TWIN COAX BNC CABLE		6	2.00	2.00	
48011	PLUG BANAND MALE BLACK		6	1.00	1.00	
48013	PLUG BANANA MALE RED		6	1.00	1.00	
67060	TYGON TU .125 ID	A/R	90	.00	.00	
71004	WIRE 2-COND 20 AWG		2	5.00	5.00	

10/30/86 BILL OF MATERIAL PAGE 1

KITTING LIST

1700018 170 ACCESSORIES RUN # QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
*	*** REVISION LEVEL ***	D 01-11-86	99	.00	.00	
1700017	170 LEAD ASBY		1	1.00	1.00	
1700019	ACCESSORY POUCH 170		6	1.00	1.00	
46001	FUSE 1/4A 3AB W/ BOX		6	2.00	2.00	
46007	FUSE 15A SLOW BLOW		6	2.00	2.00	
46019	FUSE 1/10A 250V GLASSTUBE		6	1.00	1.00	
48002	CLAMP PIGMY HIPPO		6	1.00	1.00	
48004	ADAPTER BULLET GROUND		6	1.00	1.00	
48005	ADAPTER GROUND		1	1.00	1.00	
48031	PROBE TEST RED		6	1.00	1.00	

10/30/86 BILL OF MATERIAL PAGE 1

KITTING LIST

1700016 170 FINAL ASBY RUN # QTY: 1

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
*	*** REVISION LEVEL ***	B 8-3-84	99	.00	.00	
15002	LOCKNUT 4-40 STEEL		2	1.00	1.00	
1700010	170 FRONT PANEL ASBY		1	1.00	1.00	
1700011	170 BACK PANEL ASBY		1	1.00	1.00	
1700012	170 CASE ASSEMBLY		1	1.00	1.00	
1700018	170 ACCESSORIES		1	1.00	1.00	
1700021	170 SHIPPING LIST		1	1.00	1.00	

MP MASTER
MA25720